TEST PLAN FOR THE STATIC LOAD TEST OF THE INTERFACE PLATE FOR THE ALPHA MAGNETIC SPECTROMETER (AMS)-02

TWP MHECSMBSX

Prepared by

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For

National Aeronautics and Space Administration
Lyndon B. Johnson Spacer Center

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Test Plan for the Interface Plate

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ACRONYMS AND ABBREVIATIONS

AMS	Alpha Magnetic Spectrometer
FEM	Finite Element Model
IPT	Interface Plate Test
JSC	Johnson Space Center
LMSO	Lockheed Martin Space Operations
P/N	Part Number
QA	Quality Assurance
STL	Structural Testing Laboratory
TPS	Task Preparation Sheet
TRR	Test Readiness Review

1. Test Objectives

1.1. The Interface Plate Test (IPT) will determine the ultimate strength of the interface plate fastener pattern.
1.2. The IPT will determine the load distribution in the bolts and the shear pin on the vacuum case lower interface plate.
1.3. The data taken from Section 1.2 will be used to verify the interface plate portion of the AMS-02 finite element model (FEM).

2. Test Article

The test article consists of Class III test fixture and a Class II interface plate as shown in Figure 2-1.

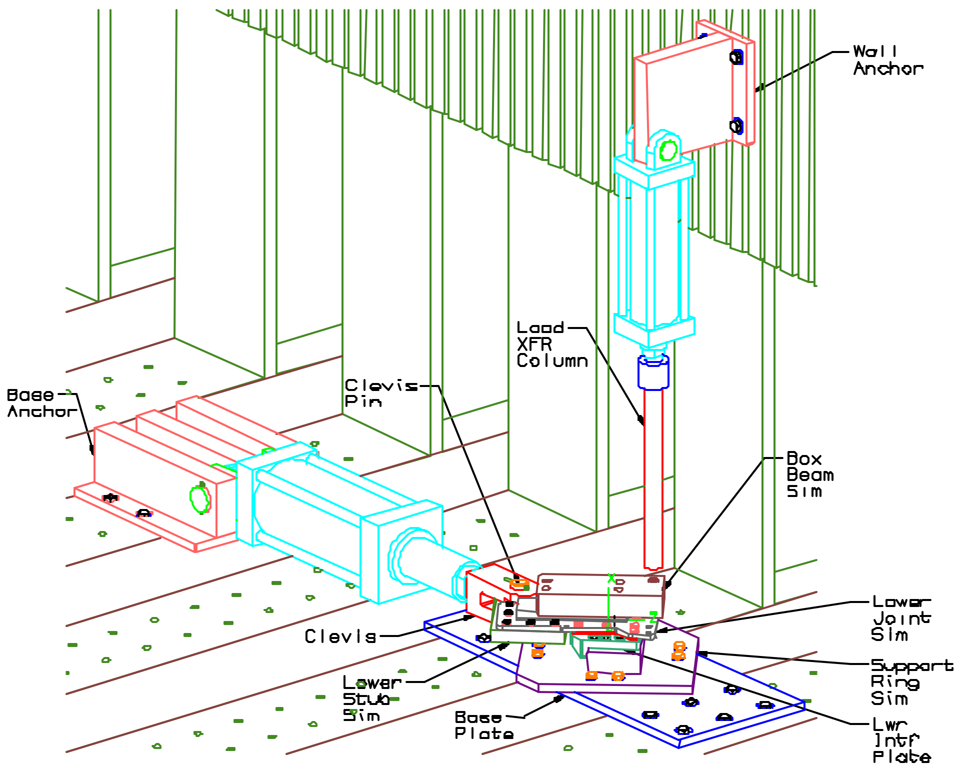


Figure 2-1 Test Article

3. Test Setup

Refer to drawing SEG36144350-401 for the assembly layout.
3.1. Install base plate, P/N SDG36144363-01 to the floor of the STL as shown. Bolt the plate to the STL using the 3rd thru 5th row of bolt holes using the STL provided 180ksi .875-14UNF bolts. Torque to 350 ft-lbf above running torque. Verify bolt strength by performing hardness testing and recording the results for each bolt.

3.2. Install base anchor assembly, P/N SEG36144364-301 to the floor of the STL as shown. Bolt the plate to the STL using the 3rd thru 6th row of boltholes using STL provided 180ksi .875-14UNF bolts. Torque to 350 ft-lbf above running torque. Verify bolt strength by performing hardness testing and recording the results for each bolt.

3.3. Install wall anchor assembly, P/N SDG36144369-301, to the strong back using STL provided 180ksi .875-14UNF bolt and T-nut. Torque to 350 ft-lbf above running torque. The wall anchor must be at least 4 feet 6 inches above the ground. Brace wall anchor plate to prevent movement if necessary. Verify bolt strength by performing hardness testing and recording the results for each bolt.

3.4. Install support ring simulator assembly, P/N SDG36144361-301, to the base plate using NAS1012-16 bolts. Standing with the strong back in front, orient the support ring simulator so that the un-chamfered corner points towards the right of the strong back and the other points to the left of the strong back. Torque bolts between 2258 and 2657 in-lbf above running torque.

3.5. Install lower interface plate assembly, P/N SDG36144356-301, to the base plate per Figure 3.6-1. Torque NAS1956C8 and C9 bolts between 399 and 469 in-lbf above running torque. Torque NAS1958C10 bolt between 968 and 1139 in-lbf above running torque.

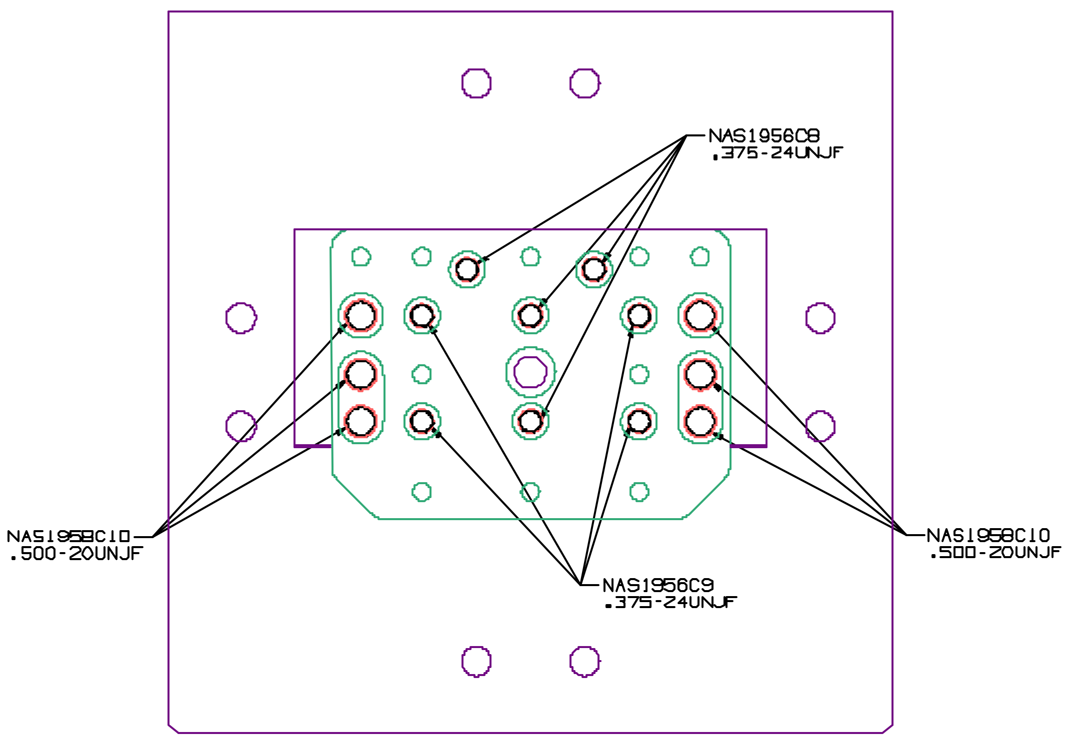


Figure 3.6-1 Bolt Location for Lower Interface Plate Assembly

3.6. Place shim, P/N SDG36144355-001, on top of the lower interface plate assembly. Orient Shim so that the 6 NAS1958C10 bolts are exposed and accessible.

3.7. Install lower stub simulator, P/N SDG36144358-001, to the lower joint simulator assembly, P/N SDG36144354-301, using 7 NAS1958-C9 bolts and 1 NAS1008-25h bolt. Torque bolts between 968 and 1139 in-lbf above running torque. Check for at least 2.25 inches of clearance between the lower stub simulator and the support ring simulator.

3.8. Install shear pin per through both lower joint simulator and lower stub simulator.

3.9. Install clevis, P/N SDG36144359-001, to the high capacity actuator, P/N SDG36144350-501.

3.10. Install high capacity actuator, P/N SDG36144350-501, to the base anchor. Secure the actuator to the base anchor using 3-inch diameter anchor pin, P/N SDG36144367-001.

3.11. Retain the anchor pin using 2 cotter pins.

3.12. Shim the high capacity actuator as needed to assure horizontal actuation. The actuator should be shimmed within .5 degree of horizontal with the pivot point at the center of the retaining pin.

3.13. Position the lower joint simulator on the lower interface plate assembly. Install the lower VC joint bushing assembly, P/N SEG39135771-301 through both the lower joint simulator and the lower interface plate assembly per TBD.

3.14. Install the lower VC joint shear pin, P/N SDG39135770-001 through the lower joint simulator, the lower interface plate, and the support ring simulator per TBD.

3.15. Secure the lower joint assembly to the lower interface assembly using 8 NAS1958-C12 bolts. Torque the bolts between 968 and 1139 in-lbf above running torque. Install instrumented bolts, P/N TBD, at the hole location marked A and B on the lower interface plate assembly.

3.16. Install box beam simulator, P/N SDG36144353-001, to the lower joint simulator assembly using 4 NAS1351N6-20. Torque between 288 and 360 in-lb above running torque.

3.17. Insert clevis pin, P/N SDG36144360-001, for the high capacity actuator through both the clevis and the lower stub simulator. Retain the clevis pin using 2 cotter pins, MS24665-644, or an equivalent.

3.18. Install thread adapter, P/N SDG36144350-503, to the lower capacity actuator, H86 A-0064.

3.19. Install load XFR column, P/N SDG36144352-001, to the thread adapter.

3.20. Install low capacity actuator to the wall anchor assembly. Secure the actuator to the wall anchor assembly using 1.75-inch diameter anchor pin, P/N SDG36144350-505, provided by the STL. During Installation, Be careful not to bend the load XFR column.

3.21. Retain the anchor pin using 2 cotter pins.

4. Test Instrumentation

4.1. The IPT will require the following instrumentation (See Table 4.1-1 for a list of gages):

- 2 instrumented bolts
- 6 Triaxial strain gages

Table 4.1-1 Summary of Strain Gages

Location	Description	Type	Qty	Gage #	Channels Required
Lower Joint Simulator Assembly	Bolt hole labeled A	Instrumented Bolt	1	A	1
Lower Joint Simulator Assembly	Bolt hole labeled B	Instrumented Bolt	1	B	1
Lower Joint Simulator Assembly	28.4° CCW from the –Z axis next to bolt in bolt hole labeled A.	Triaxial	1	1	3
Lower Joint Simulator Assembly	61.6° CW from the –Z axis next to bolt in bolt hole labeled A.	Triaxial	1	2	3
Lower Joint Simulator Assembly	28.4° CW from the +Z axis next to bolt in bolt hole labeled B.	Triaxial	1	3	3
Lower Joint Simulator Assembly	118.4° CW from the +Z axis next to bolt in bolt hole labeled B.	Triaxial	1	4	3
Lower Joint Simulator Assembly	Parallel to the load direction of the high capacity actuator next to the Lower USS to Upper USS bushing.	Triaxial	1	5	3
Lower Joint Simulator Assembly	Perpendicular to the load direction of the high capacity actuator next to the Lower USS to Upper USS bushing.	Triaxial	1	6	3
		Total	8		20

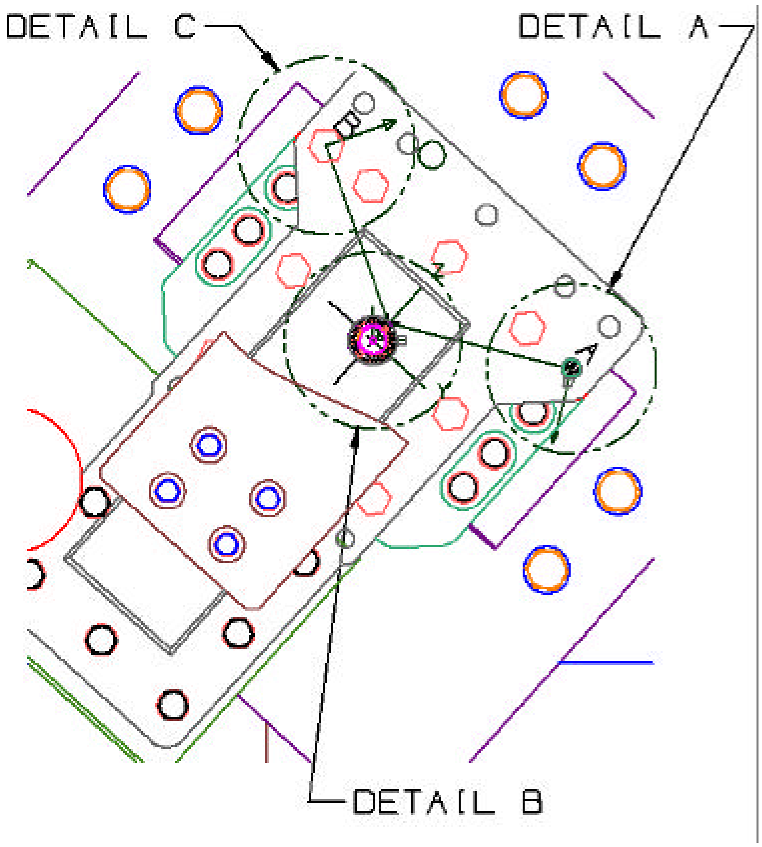
4.2. For gage setup, use material properties shown in Table 4.2-1.

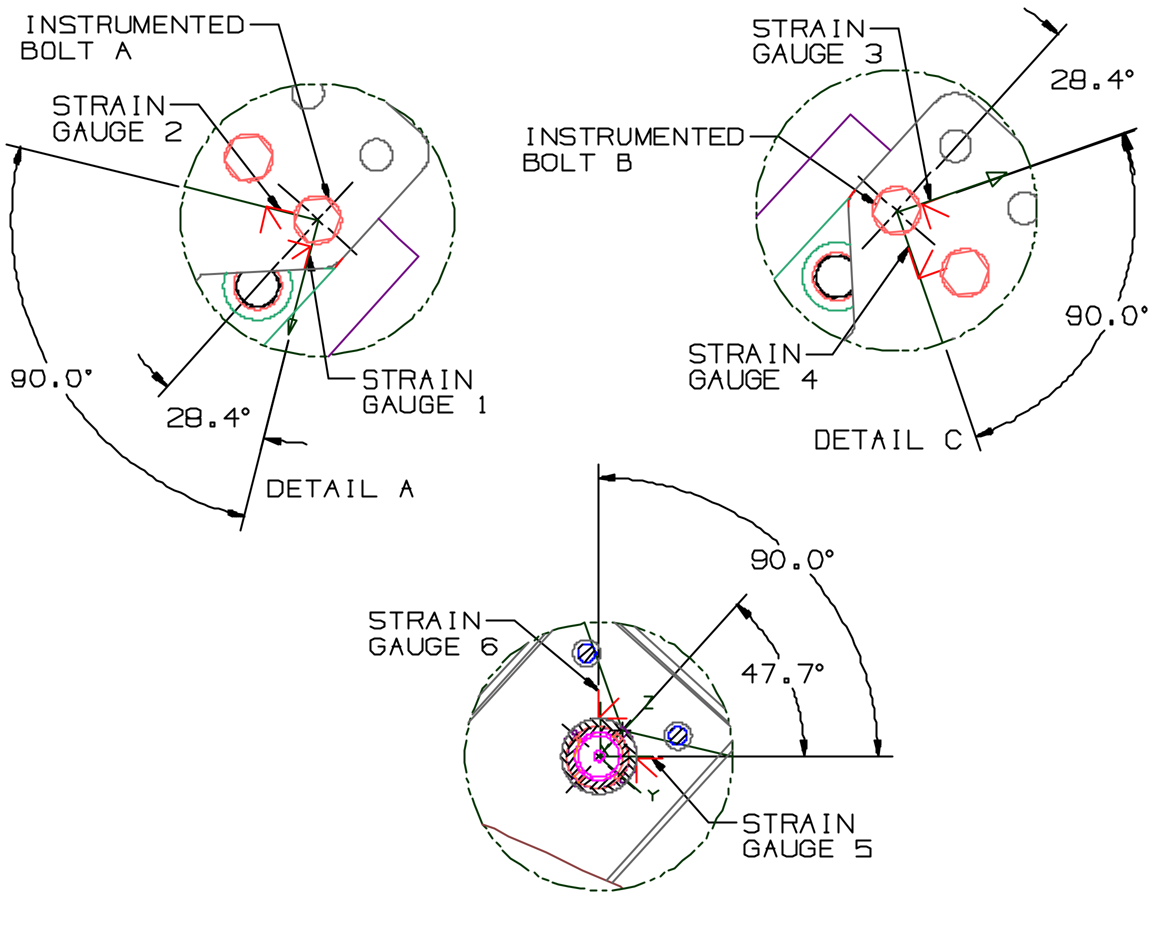
Table 4.2-1 Material Properties for Strain Gage Setup

Location	Material	E x 10^6 psi		ν
		Tension	Compression	
Lower Joint Simulator Assembly	Aluminum 7050-T7451 Plate	10.3	10.6	.33

4.3. Configure gages per Figures 4.3-1

Note: In each detail triaxial gages should be aligned with one leg of the gage oriented with the arrow. Gages should be placed as close to the bolt as possible.





DETAIL B

Figure 4.3-1 Strain Gage Bolt and Sensor Location

5. Data Requirements

This test requires the support of the JSC Building 13 STL. The STL personnel need to coordinate and deliver the following output. Numerical data should be delivered in hard copy and in electronic (ASCII or EXCEL file) format.

5.1. Photographic documentation of the test set-up and gage location is required. These photos should show the gages with the gage number labels and orientation.

5.2. Video documentation of each load case

5.3. Strain versus percent load for each strain gage. Load versus time for each load case.

5.4. Real time readouts of all data channel on a display monitor for the Test Engineer and Stress Analyst.

5.5. Real time graphical plots of the data in section TBD on a separate display monitor for the Test Engineer and Stress Analyst.

5.6. Test Data Package including test notes, control documentation, instrumentation, test data and other applicable data.

6. Loads

Table 6-1 Interface Plate Design Loads

Actuator	Design Limit Load (lbf)	Design Ultimate Load (1.4*Design Limit Load) (lbf)	Expected Failure Load (1.17*Design Ultimate Load) (lbf)
1	8283	11597	13568
2	48808	68332	79948

Note: Test hardware is designed to the Expected Failure Load with a Factor of Safety of 3.0. Test hardware had a minimum Margin of Safety with these Loads/Factors of 0.22. (22%)

The loads will be applied simultaneously and incrementally in 10% intervals from the initial to the final load listed in table 6-2. The load must be applied as shown in figure 6-1. Either the test lead or the test engineer can increase the final loads to the 1.22 * Expected Failure Load or maximum capability of the actuators, whichever one is lower. Failure of the hardware at loads above 100% of the Design Ultimate Load is acceptable.

Table 6-2 Interface Plate Test Loads

	Initial Load (lbf)	Ten Percent Increment	Expected Final Load (lbf)
Actuator 1	0	1357	13568
Actuator 2	0	7995	79948

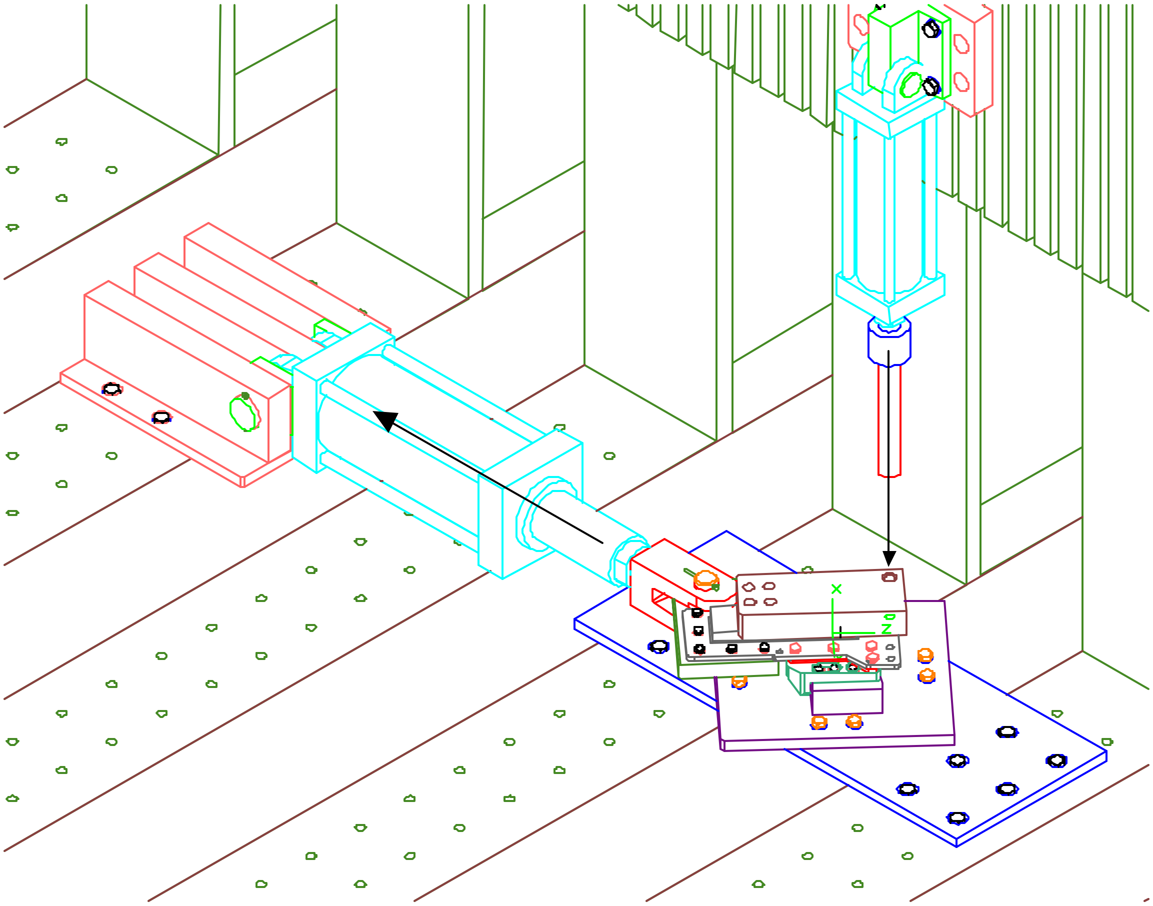


Figure 6-1 Interface Plate Test Load Direction

7. Test Procedure

7.1. Extend the rod of the low capacity actuator until the load XFR column is in contact with the box beam simulator. The rounded end of the column should rest in the rounded hole of the box beam simulator. The column should exert no more than 1 lbf of load on the box beam simulator.

7.2. Retract the rod of the high capacity actuator until the clevis pin is in contact with the lower joint simulator assembly. The clevis pin should exert no more than 1 lbf of load on the lower joint simulator assembly.

7.3. Zero strain gages

7.4. Begin video recording of test

7.5. Begin recording of the strain gage

7.6. Print data

7.7. Apply loads from table 6-1, in steps of 10% increments. Hold each step for at least 10 seconds. Hold longer upon direction of the test lead or the test engineer. Print data.

7.8. Increase loads beyond 100% if directed by either the test lead or test engineer. Increase loads in 10% increments. Hold each step for at least 10 seconds. Print data. Stop the test when the loads reach the capability of the actuator or when the hardware fails. It is acceptable for the hardware to fail when the loads exceed 100% of listed values in table 6-1.

7.9. Return load to zero over same time required for reaching maximum applied load. Do not stop unless otherwise specified by either the test lead or the test engineer.

7.10. Terminate test

7.11. Stop video recording

7.12. Break down test setup as directed by test engineer.

8. Pass/Fail Criteria

Table 8-1 Pass/Fail Criteria

Pass/Fail Criteria	
Design Limit Load	Design Ultimate Load
No Detrimental Deformations	No Failure

9. Test Support

This test will be used for FEM verification and strength determination. Full Quality Assurance (Q.A.) coverage is required. The review board will determine test readiness. The test review board will approve continuation of the test/procedures. Table 9-1 defines the members of the review board. Other members may be added as needed.

Table 9-1. Test Personnel

Responsibility	Representative	Contact
Test Engineer	Hsing Ju / LMSO	281-333-7494
Test Lead Engineer	Phil Mott / LMSO	281-333-6451
Project Manager	Kenneth Bollweg / LMSO	281-335-2714
Structural Lead	Trent Martin / LMSO	281-335-2139
Stress Lead	Chittur Balasubramanian / LMSO	281-333-7518
Stress Analyst	Howard Carter / LMSO	281-333-7339
Safety	Robert Seiwell/Hernadez	483-6348
Q.E.	David Fretz	281-483-6375 281-763-7853
Facility Personnel	Don Wilbanks / LMSO	281-483-8819
Chairperson	James Lester / ES5	281-483-8949